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THE UNITED STATES
STRATEGIC BOMBING SURVEY

SUBMARINE ASSEMBLY
SHELTER
FARGE, GERMANY

MUNITIONS DIVISION

JANUARY 1947

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THE UNITED STATES
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Dates of Plant Survey:

21 May-31 May 1945

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This report was written primarily for the use of the U. S. Strategic Bombing Survey in the preparation of further reports of a more comprehensive nature. Any conclusions or opinions expressed in this report must be considered as limited to the specific material covered and as subject to further interpretation in the light of further studies conducted by the Survey.

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Foreword

The United States Strategic Bombing Survey was established by the Secretary of War on 3 November 1944, pursuant to a directive from the late President Roosevelt.

The officers of the Survey were:

Franklin D'Olier, Chairman.
Henry C. Alexander, Vice-Chairman.

George W. Ball,
Harry L. Bowman,
John K. Galbraith,
Rensis Likert,
Frank A. McNamee, Jr.,
Paul H. Nitze,
Robert P. Russell,
Fred Searls, Jr.,
Theodore P. Wright, Directors.

Charles C. Cabot, Secretary.

The Table of Organization provided for 300 civilians, 350 officers and 500 enlisted men. The Survey operated from headquarters in London and established forward headquarters and regional headquarters in Germany immediately following the advance of the Allied armies.

It made a close examination and inspection of several hundred German plants, cities and areas, amassed volumes of statistical and documentary material, including top German government documents; and conducted interviews and interrogations of thousands of Germans, including virtually all of the surviving political and military leaders. Germany was scoured for its war records which were found

sometimes, but rarely, in places where they ought to have been; sometimes in safe-deposit vaults, often in private houses, in barns, in caves; on one occasion, in a hen house and, on two occasions, in coffins. Targets in Russian-held territory were not available to the Survey.

Some two hundred detailed reports were made. During the course of its work, the Survey rendered interim reports and submitted studies and suggestions in connection with the air operations against Japan.

While the European War was going on, it was necessary, in many cases, to follow closely behind the front; otherwise, vital records might have been irretrievably lost. Survey personnel suffered several casualties, including four killed.

The Survey studied the effects of the air attack on Japan and further reports have been submitted to the Secretary of War and the Secretary of the Navy.

UNITED STATES STRATEGIC BOMBING SURVEY

MUNITIONS DIVISION - SUBMARINE BRANCH

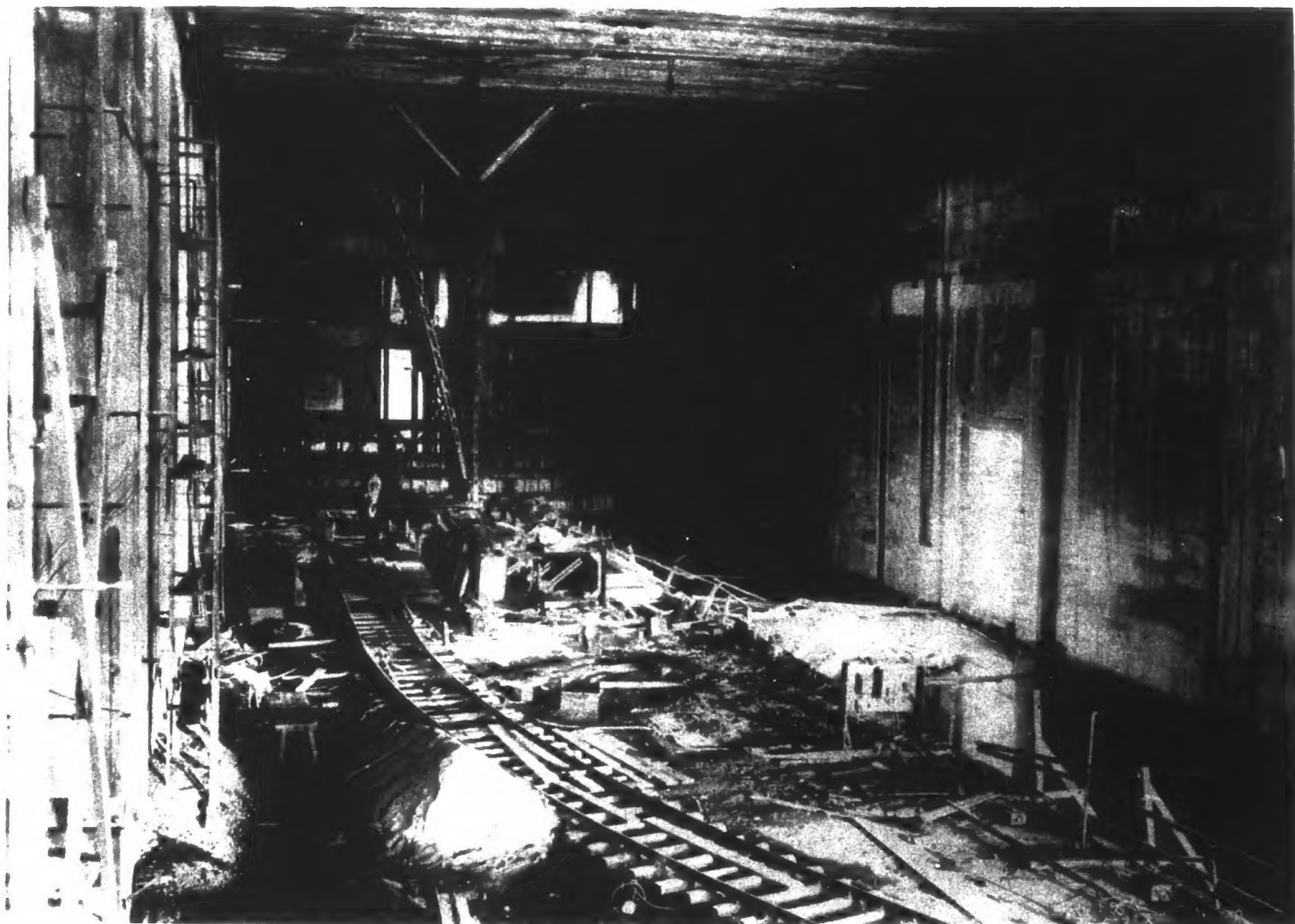
PLANT REPORT NO 7

SUBMARINE ASSEMBLY SHELTER AT FARGE

CODE NAME - "VALENTIN"

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Interior view showing positions 12 and 13 at NW corner of building indicating water tight gates to allow flooding of position 12.

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SUBMARINE SHELTER - VALENTIN

I SUMMARY

1. The colossal submarine assembly shelter known by the code name of VALENTIN is located close to the village of Farge on the eastern shore of the Weser River, approximately 10 miles north of Bremen. It is a rectangular building on monolithic foundations with reinforced concrete walls and roof. The structure, at the time of the survey, was approximately 90 per cent completed and was intended to be used as an assembly plant for the prefabricated sectionalized Type XXI submarine. According to the Type XXI modified construction program of 26 October 1944, VALENTIN was to start assembly in March of 1945 and attain full capacity production of 14 submarines per month by August 1945, at which time it was planned to eliminate the assembly yards of Blohm & Voss, Hamburg, and Deutsche Schiff und Maschinenbau A.G. (Deschimag), Bremen. The structure was designed as a bombproof assembly plant. No production was ever begun in this shelter.

2. The overall dimensions of the building are as follows:

length	1375 ft
width	315 ft
height above ground	96 ft
depth below ground	41 ft

The walls at the time of the survey were 14 feet, nine inches thick; and approximately two-thirds of the roof was 23 feet thick, with the remaining one-third being 14 feet, nine inches thick and in the process of being brought up to the 23 feet in thickness. The total built in space is approximately 1,400,000 cubic yards; a total of approximately 650,000 cubic yards of concrete were used.

3. VALENTIN was attacked twice by air raids:

<u>Date</u>	<u>Attacking Air Force</u>	<u>Tons Dropped</u>	<u>Number of hits</u>	<u>Near Misses</u>
27 March 1945	RAF	173	2	11
30 March 1945	8th AF	139.5	1	Several

4. In the RAF attack, 13 22,000-lb bombs were dropped, four 12,000-lb bombs, and 12 1,000-lb bombs. The two direct hits were by 22,000-lb bombs resulting in penetrations through the roof. In the Eighth AF raid, there was one direct hit by a 4,500-lb bomb, the only type of bomb carried

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SUBMARINE SHELTER - VALENTIN

resulting in a small crater. It is believed that this bomb either did not explode or that the fuze functioned prematurely. Near-misses of the 12,000 and 22,000-lb bombs caused substantial damage to construction facilities.

5. The two hits scored with the 10-ton bomb struck that portion of the roof which was only 14 feet, nine inches thick, and penetrated approximately eight feet, the force of the explosion causing the breaks through the roof. The thickness of the roof proved the building immune against interior explosions since no perforation resulted. In all probability, had the roof been 23 feet thick overall, it would have been entirely bombproof.

6. Photographic interpretation and other Intelligence fairly described the structure and its intended use, and accurately described the two perforations in the roof, although the amount of interior destruction could not be established. Intelligence further indicated that in the Eighth AF raid, all 62 of the 4,500-lb RA/SP (Rocket Assisted - Special Purpose) bombs missed the target, although one hit was actually scored.

II THE PLANT AND ITS FUNCTION IN ENEMY ECONOMY

1. The project of building submarines in a bombproof shelter originated as far back as late 1941. As Allied air attacks increased in numbers and severity, the decision was reached to construct bombproof structures for submarine production in certain areas along the German north shore. In the Speer-Flensburg documents, Speer reported on 8 November 1942 that Hitler wanted the building of submarine shelter in various shipyards to start without delay. In the Bremen area, the original decision reached was to construct two shelters on the Weser River for the two important yards in the vicinity: Deschimag at Bremen and Bremer Vulkan at Vegesack. The code name for the project at Deschimag was HORNISSE, and for the project at Bremer Vulkan, VALENTIN. The two shelters were to be operated by the private ship-building yards named.

2. The final location selected for the VALENTIN shelter was near the village of Farge which is within five miles north of Vegesack. Construction was begun early in 1943. (Exhibit A) Shortly after starting construction, the decision was reached within the Speer Ministry's Hauptausschuss Schiffbau (Main Committee for Shipbuilding) to convert to the building of the prefabricated Type XXI

SUBMARINE SHELTER - VALENTIN

submarine, and VALENTIN was redesigned as the assembly plant, the intention being that it would assemble 14 complete boats per month, and, by August 1945, to eliminate the assembly yards of Blohm & Voss in Hamburg and Deschimag in Bremen. The planned production schedule was as follows:

MODIFIED TYPE XXI CONSTRUCTION PROGRAM OF 26 OCTOBER 1944 PROGRAM FOR VALENTIN - 1945

<u>March</u>	<u>April</u>	<u>May</u>	<u>June</u>	<u>July</u>	<u>August</u>
3	6	9	12	12	14

Capacity production was to be attained by August 1945 and thereafter continue at the rate of 14 per month.

3. The plan also provided that the eight sections for the prefabricated Type XXI should be fitted out at HORNISSE in Bremen and at another proposed shelter known by the code name of WESPE which was to be constructed at Blohm & Voss in Hamburg. HORNISSE was to fit out Sections, 3, 4, 5 and 6, and WESPE was to fit out Sections 1, 2, 7 and 8, and these sections were then to be shipped to VALENTIN by water transportation for final assembly into complete submarines. There the assembling could be accomplished under conditions of maximum protection and no construction would be necessary on open slipways which were particularly vulnerable to Allied air attack.

4. The execution of this gigantic program for the construction of VALENTIN was entrusted to a building office created by the OKM (Supreme Naval Headquarters) and known as "U-Weser" (Oberbauleitung U-Weser). Contracts for the actual work were awarded to various contractors, the most important being the firm of Wayss & Freytag, which did not only straight concrete work, but also built prefabricated arched trusses. The firm of Agatz & Bock acted as consulting engineers.

5. Since the building was never completed, a full evaluation of its importance in the enemy economy cannot be made, but there is no doubt that it ranked high in OKW's (Supreme Wehrmacht Command) priorities. Its potential value, from the German point of view, was that it would permit 14 submarines of Type XXI to be completed per month (assuming the original planning was correct) under conditions of maximum protection from the time the fitted-out sections were first brought together until the time when a completed vessel could be put into the water ready for

SUBMARINE SHELTER - VALENTIN

its trials and delivery to the naval authorities. Its operation would then permit all necessary shipyards to concentrate on section fitting out and component manufacturing.

6. The plant is located close to the convex shore of a bend of the river Weser, so as to minimize silting. (Exhibit B) It consists of one building in the process of construction, about 90 per cent complete, and is at present surrounded by numerous temporary facilities for the production of concrete, precast arched trusses, assembly of steel units and other construction activities. The VALENTIN building occupies an area of approximately 41,200 square yards, and is rectangular in shape, its longitudinal axis lying in a NW-SE direction. Excavation and dredging to a depth of 23 feet were in progress on the strip of land between the river and VALENTIN's entrance gate, to enable barges of 3,000-ton capacity and submarines to enter the shelter.

7. It was intended to bring to VALENTIN sections prefabricated fitted out at Deschimag's HORNISSE and Blohm & Voss' WESPE by means of barges on waterways.

8. A barge was to enter VALENTIN by Gate G. (Exhibit B) A 200 ton crane was to pick up the section and put it on a bogey standing on Turntable T-1. The bogey would then move on a track to Turntable T-2, where a traveling, overhead 200-ton crane would pick up the section and place it in the "ready use" space along the south wall. The bogey would turn at 90 degrees to the left and move along the track. As soon as a train of eight empty bogies were assembled, the 200-ton crane would select a set of eight sections in the "ready use" space and assemble a complete submarine. This train would then move through the building from Stations 1 to 12, during which various operations were carried out until the submarine was ready for launching. At that stage Gates G-1, G-2, and G-3 were closed and space filled with water when the submarine was floated from 12 to 13. (Photo Frontispiece) On reducing the level of the water in 13 to that of the river, G-1 and G would be opened, and the submarine would leave the building. On the raising of G-2, the empty bogies could be used again for transporting sections from a barge to the storage place.

9. The part of the building marked "M" was reserved for machines and shops which were to be installed on three floors, including oxygen and acetylene producing plants, complete electric power stations and various auxiliaries.

SUBMARINE SHELTER - VALENTIN

10. Apart from the Water Gate G, VALENTIN has four other doors. Doors "Da" are scheduled for supplies for the machine shops. "Dd" was to be an emergency door, and "De" provided an exit through which sections could be moved into the open space south of VALENTIN. (Photo 1 and Exhibit A) The space lying to the south of VALENTIN from the SW corner to "Dd" was earmarked for additional building.

11. As can be seen from Exhibits B, C and D, VALENTIN was a very simply designed building. Its foundation consists of longitudinal monolithic concrete foundations supporting the outer walls and arched partitions. The design was based on the assumption that the soil would withstand a pressure of 114 pounds per square inch, which is very high for ground consisting of approximately 36 feet of fine quartz sand, with a small silt and mixture lying on a very thick strata of dense clay. The consulting engineers were prepared for a permanent settling of the building of 12 inches. In reality a 9.5-inch settling was recorded.

12. The original thickness of the walls was, and now is, 14 feet, nine inches. It was, however, designed to be increased at a later date to 23 feet, due to the fact that the heavier bombs were anticipated.

13. The roofs consist of a slab which is no doubt the most interesting feature of this colossal building. At first it was designed to be 14 feet, nine inches. For the reason stated above, it was decided to increase the thickness to 23 feet, and work had begun in this direction. Experience, however, having shown that 23 feet might not be proof against future bomb developments, it was planned to increase the thickness of the roof slab by another nine feet, nine inches to a total of 32 feet, nine inches. In order to save work and material, it was decided to use self-supporting shuttering. Pre-stressed arched trusses were designed for this purpose. (Photos 2 and 12) These trusses were precast on a specially constructed site (Photo 3), then carried by rail to the building and installed in position close to each other. In view of the difficulty in handling such large items, gaps of from one and a half to three inches wide remained between the three-foot wide bases of the arches. After grouting these gaps, a spiral reinforcement was placed between these trusses, and concrete was pumped from the mixers on the ground to a boosting pump substation on the roof. From there the concrete could be pumped to any place on the roof where it was poured to a depth of 14 feet nine inches, superposed



Photo 1 - View of VALENTIN from SW corner showing door De...



Photo 2 - Arch truss seen from W, showing series of taddy trusses.

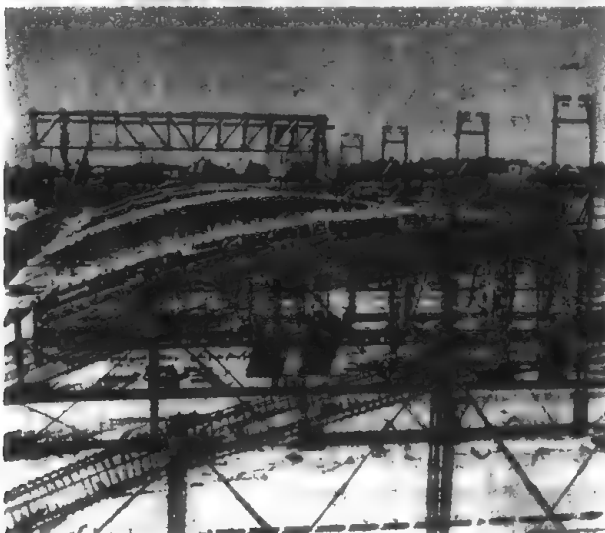


Photo 3 - Arch trusses in production.



Photo 4 - View of arch...

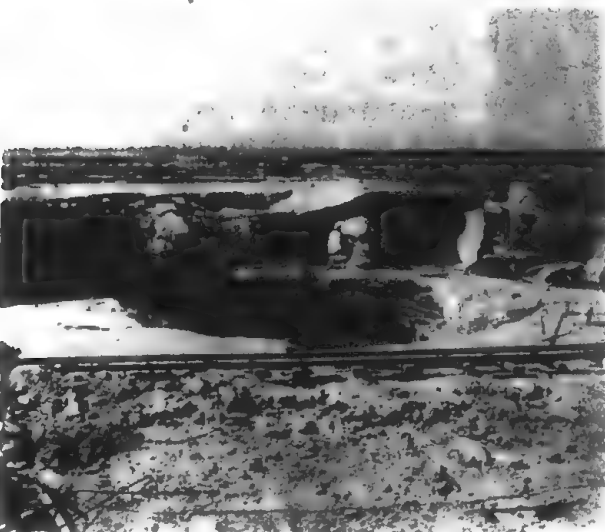


Photo 5 - View of crater no 16 from N, showing spelling cracks in the step.



Photo 6 - View of crater no 16 from VALENTIN...

SUBMARINE SHELTER - VALENTIN

on the arched trusses. This depth represents the maximum weight these trusses could carry. Even at that rate the live-load amounted to 5,000 pounds per foot-run of one truss. After the concrete had set, an additional layer of eight feet, three inches of monolithic concrete was added on top of the original slab. The pouring of the concrete was continuous, with three shifts and up to 2,000 men per shift.

14. As stated previously, VALENTIN was being erected by OKM, and is, therefore, the property of the German state. OKM's building office U-Weser, was in charge of the various private contractors executing the job. The following persons belonging to the above organizations were interviewed:

Edo Meiners	-	civil engineer)	
W. Bosselman	-	civil engineer)	
Fr. Hess	-	civil engineer)	employed by
Herr Mohr	-	mechanical engineer)	German Navy
Dr Schmidt	-	civil servant)	
Karl Grisslich				
Hans Sterz				
Dr Kranz)	managers of		
Dr Lackner)	Agatz & Bock		
Mr Karl Hermann	-	director of Deschimag		
Mr Robert Kabelak	-	director of Bremer Vulkan.		

III ATTACKS

1. The bombing data are as follows:

<u>Date</u>	<u>Time</u>	<u>AF</u>	<u>No of A/C</u>	<u>Altitude of Release</u>	<u>HE</u>		<u>Total Tons</u>
27/3/45	1300	RAF	18	16,500	13	22,000 lb bombs	173
					4	12,000 lb bombs	
					12	1,000 lb bombs	
30/3-45	1423	8th	31	20,000	62	4,500 lb RA/SP bombs	139.5
	1505						

IV EFFECTS OF BOMBING

1. Physical Damage to Building

a. Two 22,000-lb bombs hit the roof of VALENTIN almost in the center of the building a few feet off the step formed by the additional eight feet, three inches poured over the original 14 feet, nine inches causing

SUBMARINE SHELTER - VALENTIN

craters 15 and 16. (Exhibits A and E)

b. The bombs penetrated some six to eight feet before detonating, the center of the explosion being practically on the surface of the slab, as clearly shown by fragmentation marks on the wall of the periscope testing superstructure opposite the eight feet, three inches step, which were only four inches above the upper surface of the slab.

c. Only a few reinforcement rods at the top of the slab were blown upward, the remainder being blown downwards. (Photo 4)

d. The concrete of the 14 feet, nine inches slab shows spalling cracks directed downward, whilst the eight feet three inches high "step" (additional layer of concrete) next to the crater shows spalling crack running upwards. (Photo 5)

e. At the time of the survey, crater 16, which, according to information obtained from Germans, measured approximately 30 feet on top and 25 feet in diameter in the narrowest part, had almost a square shape at the bottom due to removal of a few broken parts of nine shattered trusses and general trimming up. (Photos 6 and 7)

f. Crater 15, much the same as crater 16 in shape and dimensions, was covered by heavy steel "I" sections on the date of survey, and the Germans were planning to repair the eight damaged arched trusses. (Photos 8 and 9) Size of sections was 39 inches high, 12 inches wide, web flange one and three-eighths inches thick. German standard size "1-100".

g. The explosion brought down a considerable mass of concrete. (Photo 10) It weighs approximately 800 tons per crater. Numerous splinters were found inside and on the roof of VALENTIN, most of them being two inches thick. (photo 11) A general view of the damage can be clearly seen in Photo 12.

h. The debris knocked down two travelling cranes. It is reported that the crane operator standing at that time on the adjacent crane escaped injury; this can be taken as a proof that the blast did not penetrate inside the building. (Photo 8)

i. Crater 18 (Exhibit A) is probably due to a



Photo 7 - View of crater no. 16 from floor of VAFN 11, looking SW.



Photo 8 - View of crater no. 15 from floor of VAFN 11.



Photo 9 - View of crater no. 15 covered with debris. Steel joists over crater no. 15.



Photo 10 - Debris on floor underneath crater no. 15.



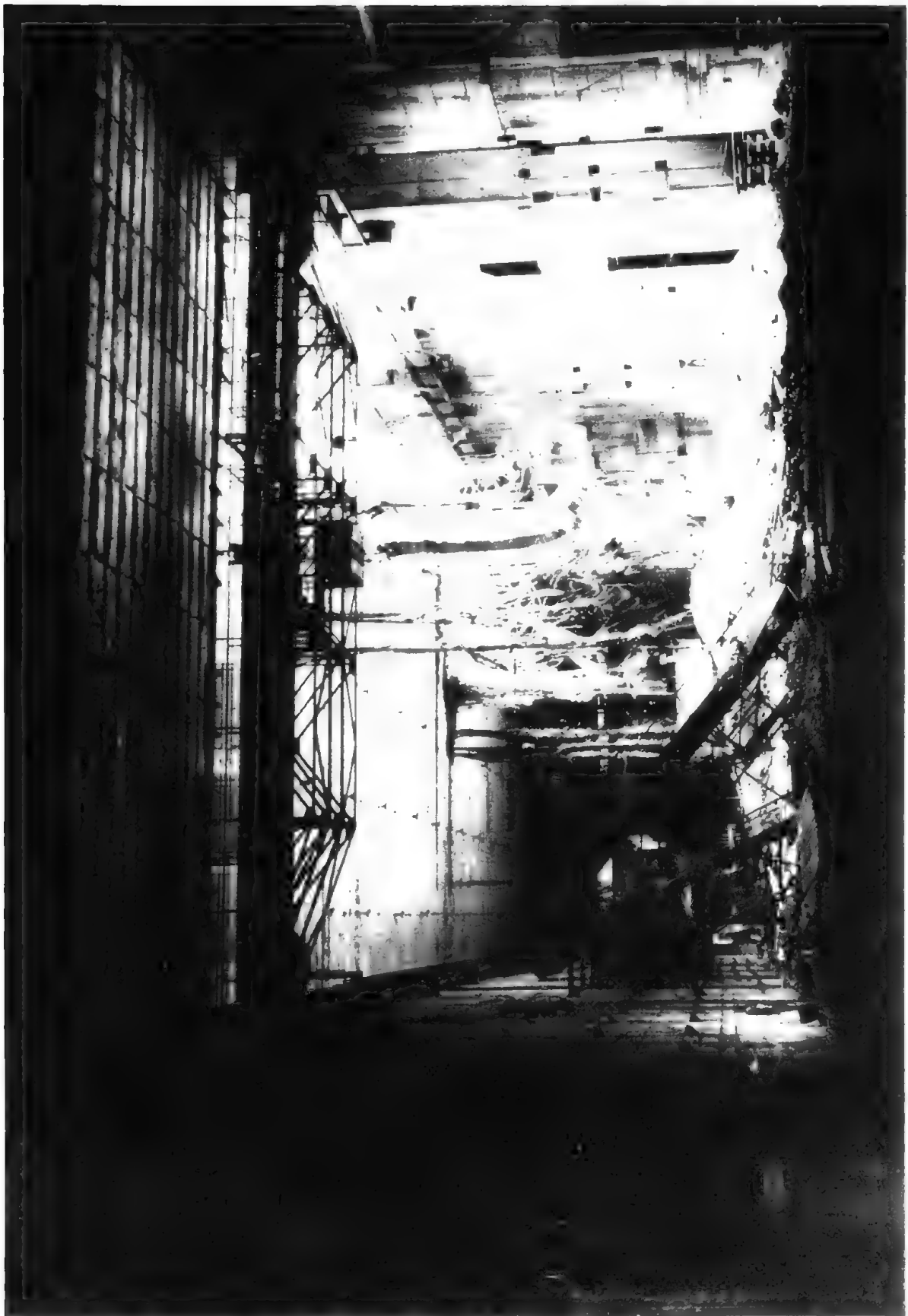
Photo 11 - Hole 11 x 6 feet x 2 inches deep, 22 feet around the hole. Located on floor near VAFN 11, under crater no. 15.

SUBMARINE SHELTER - VALENTIN

4,500-lb RA/SP or "Disney" bomb, since air coverage photos reveal, and Germans confirm, that it is a result of the raid of 30 March 1945. It measures eight feet nine inches in diameter and is about two feet five inches deep. Numerous small fragments, some 1/8 inch and some one inch thick, were found around this crater. Most fragments were not, or were only partly, sheared at a 45 degree angle. The 1/8-inch fragments are badly twisted and seem to have been "blued" by heat. The size of the crater suggests that the fuze might have functioned prematurely.

j. Other hits by various bombs on the ground around VALENTIN caused the following damage to building machinery, sheds and similar auxiliaries:

- (1) destroyed most of the two platforms supporting batteries of concrete mixers, and destroyed two mixers, rail tracks and wooded bridge-work leading to the two plants were severed, craters 4 and 7
- (2) destroyed shed in vicinity of the eastern mixer battery
- (3) destroyed storage sheds between the eastern and western mixer batteries.
(Photo 13 depicting crater 5)
- (4) destroyed ramps and piping for delivering concrete to roof, and boosters sub-pumpcrete station on roof and scattered piping and builders' material (due to blast from one of the hits on roof)
- (5) damaged reinforcement bending plant by direct hits, bombs 10 and 11
- (6) severed the main rail line at crater 3
- (7) made the biggest crater, No 13, caused by a hit next to the arched trusses pre-fabricating plant (see Photos 14 and 15); this bomb displaced and upset numerous ready arched trusses, and destroyed the gantry which ran above the plant (see Photos 16, 17 and 18); the second gantry, undamaged, can be seen on Photo 18.
- (8) Bomb 1 destroyed the canteen.



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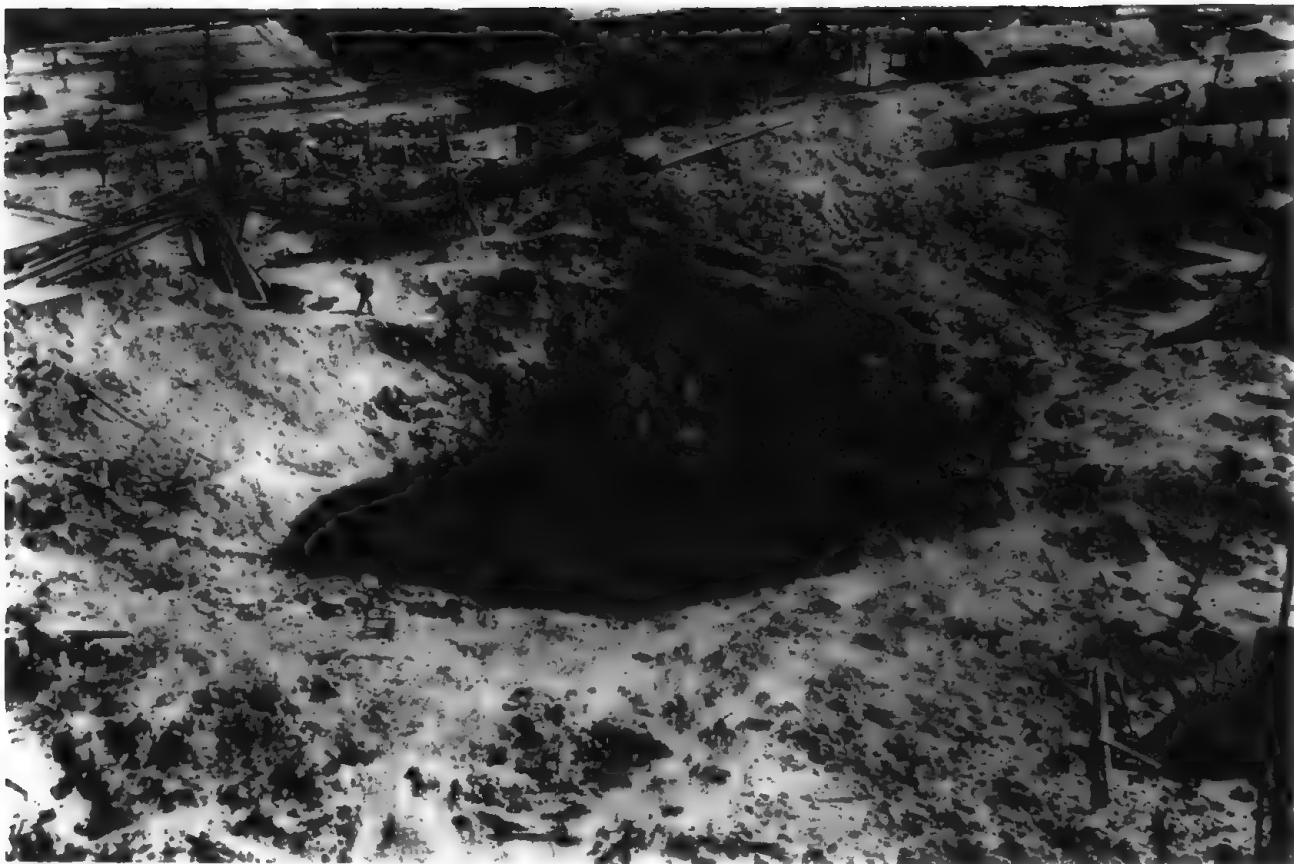


Photo 13 - View of crater 5 taken from top of VALENTIN looking north.



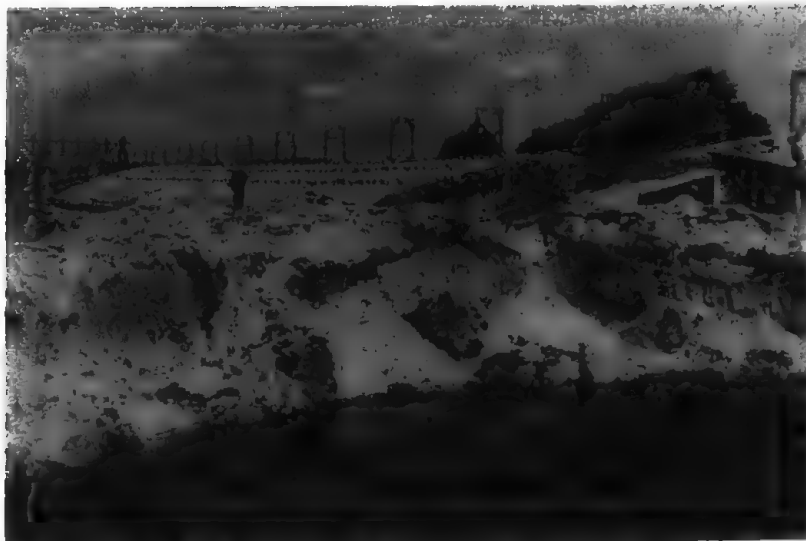


Photo 15 - Curing area for pre-cast trusses as viewed from south across crater 13.



Photo 16 - View of damage to arched trusses storage from east.



Photo 17 - View of damage to arched truss storage from south.



Photo 18 - View of damage to arched truss storage and warehouse.



Photo 19 - UXP 4,500-15, RA SP boom.

SUBMARINE SHELTER - VALENTIN

- (9) Several camuflet Type C craters of the 4,500 lb RA/SP bombs were made around the SW end of VALENTIN, but no visible damage can be seen; one UXB, a 4,500 lb RA/SP, can be seen on Photo 19.
- (10) The floating dredge used for excavating the shore in front of VALENTIN was hit in the raid of 27 March 1945, and sank.

V EVALUATIONS AND IMPRESSIONS

1. So far as the three hits on VALENTIN are concerned, they show clearly that even the 14 foot, nine inch thick roof made the building immune against interior explosions, inasmuch as the 22,000 lb M C bombs did not perforate the roof of this thickness, and it is only the force of the explosion which caused a break-through in the roof.

2. Falling debris, in spite of its very considerable weight, would not damage a submarine under construction as badly as a relatively small bomb exploding on, or close to, a boat.

3. In all probability a 23 foot slab would withstand the 22,000 lb bomb; but whether it is entirely proof against repeated hits by such bombs, can only be determined by experiments. The 4,500 lb RA/SP bombs are not effective against such targets, although they will undoubtedly perforate lighter slabs.

4. Heavy structures such as VALENTIN, with a 23 foot slab, are unlikely to be seriously damaged by the bomb, or rocket assisted missile, used.

5. Construction delay, insofar as the building schedule is concerned, is fully illustrated by Exhibits F and G showing how air raid warnings and raids slowed down the production and pouring of concrete.

6. The raid of 27 March took place so shortly before the collapse of German resistance in this area, that there is no record of the time and material required to repair all damage done to the building and auxiliary plants.

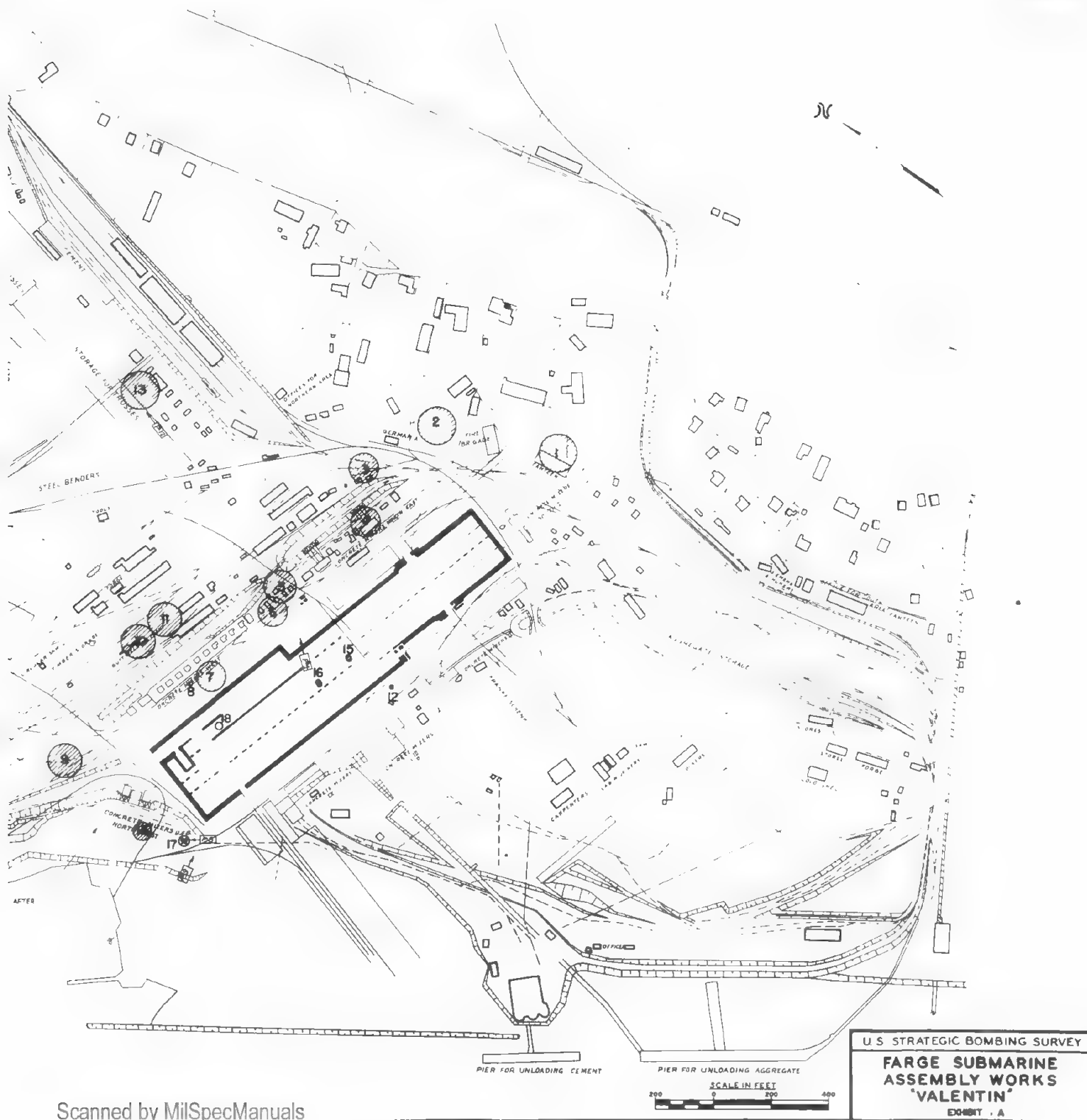


Reconnaissance Photo after raid of 9 April 1945.

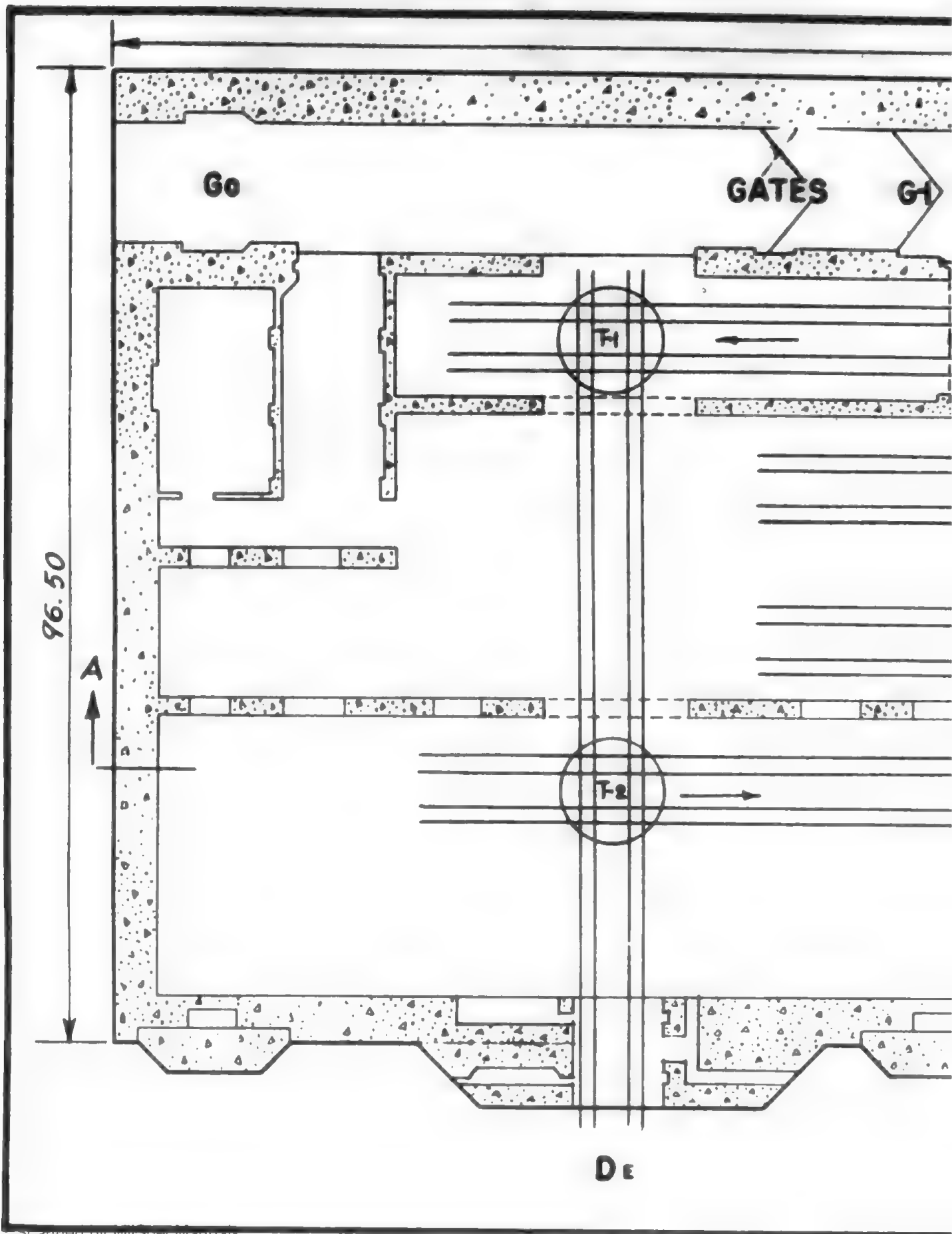
SUBMARINE SHELTER - VALENTIN

EXHIBIT A

GENERAL LAYOUT AND BOMB PLOT



PLAN OF BUILDING



DRY DOCK FOR FLOATING SPACE

G-1

DATE G-2

DATE G-3

OPERATION 12

OPERATION 7

OPERATION 6

OPERATION 1

STORAGE SPACE FOR 25 SE

FLOOR F
N

Ds

OPERATION 10



OPERATION 9



OPERATION 4



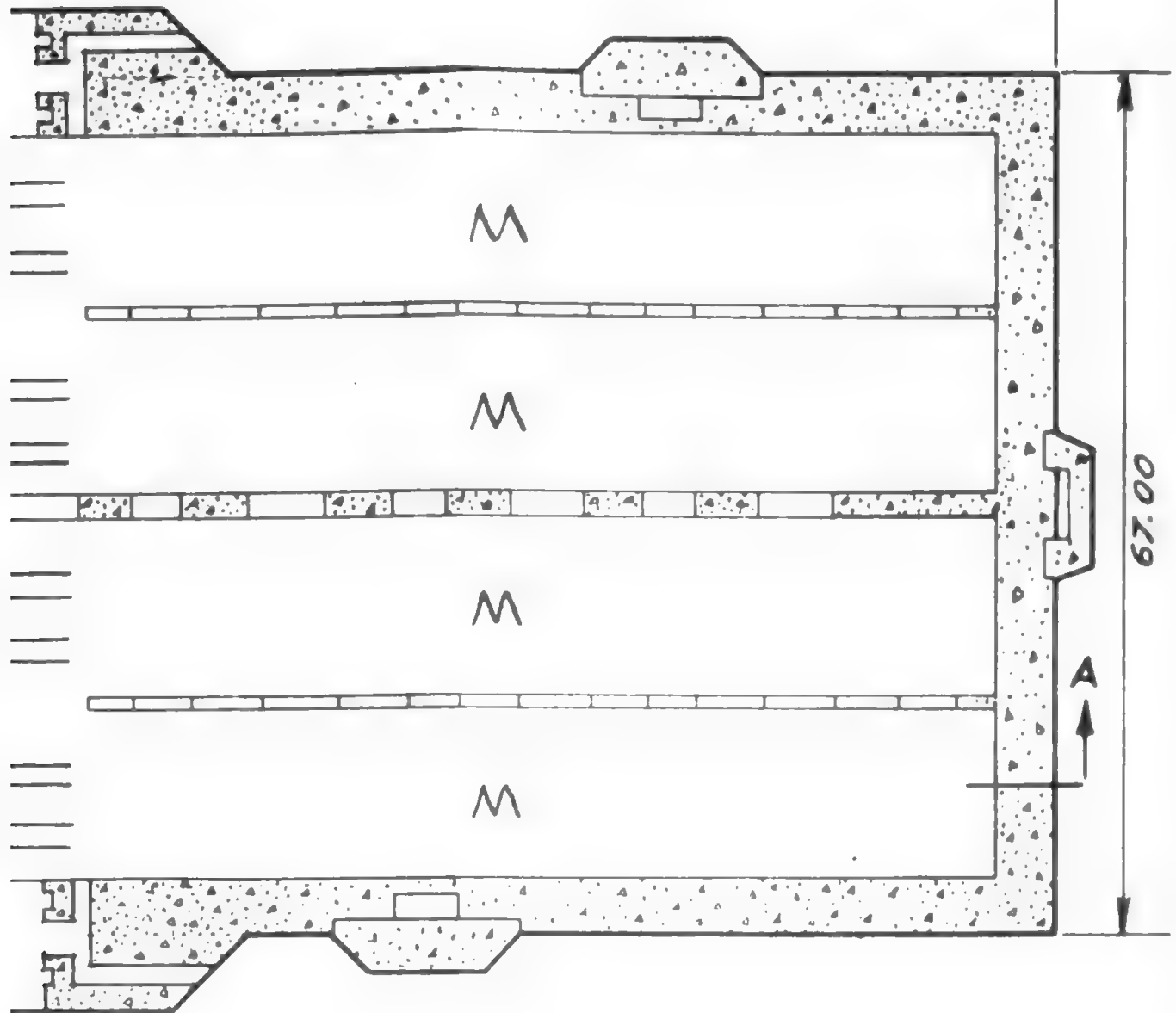
OPERATION 3

Dd

D-3



CONFIDENTIAL



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A

SCALE IN FEET

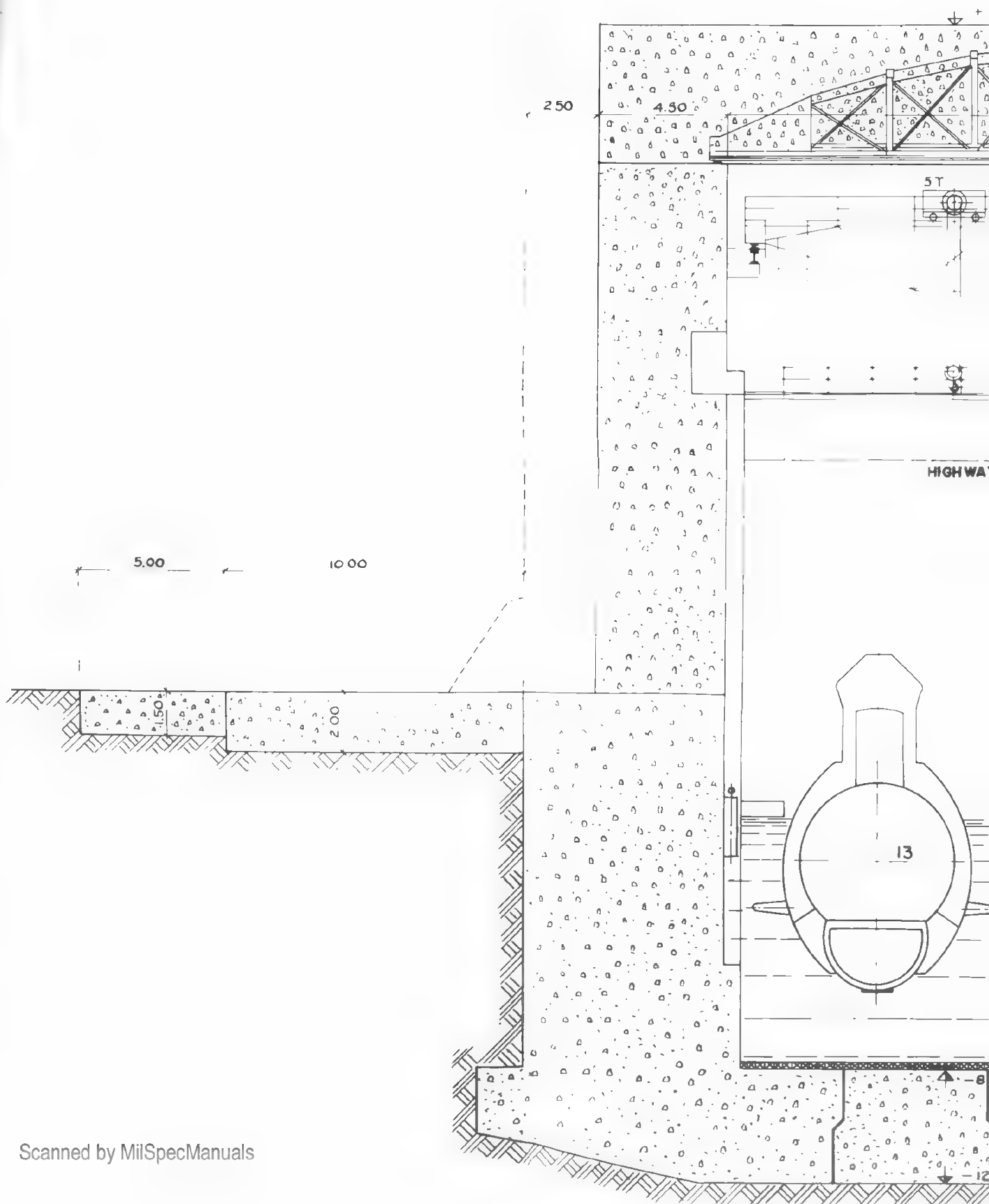


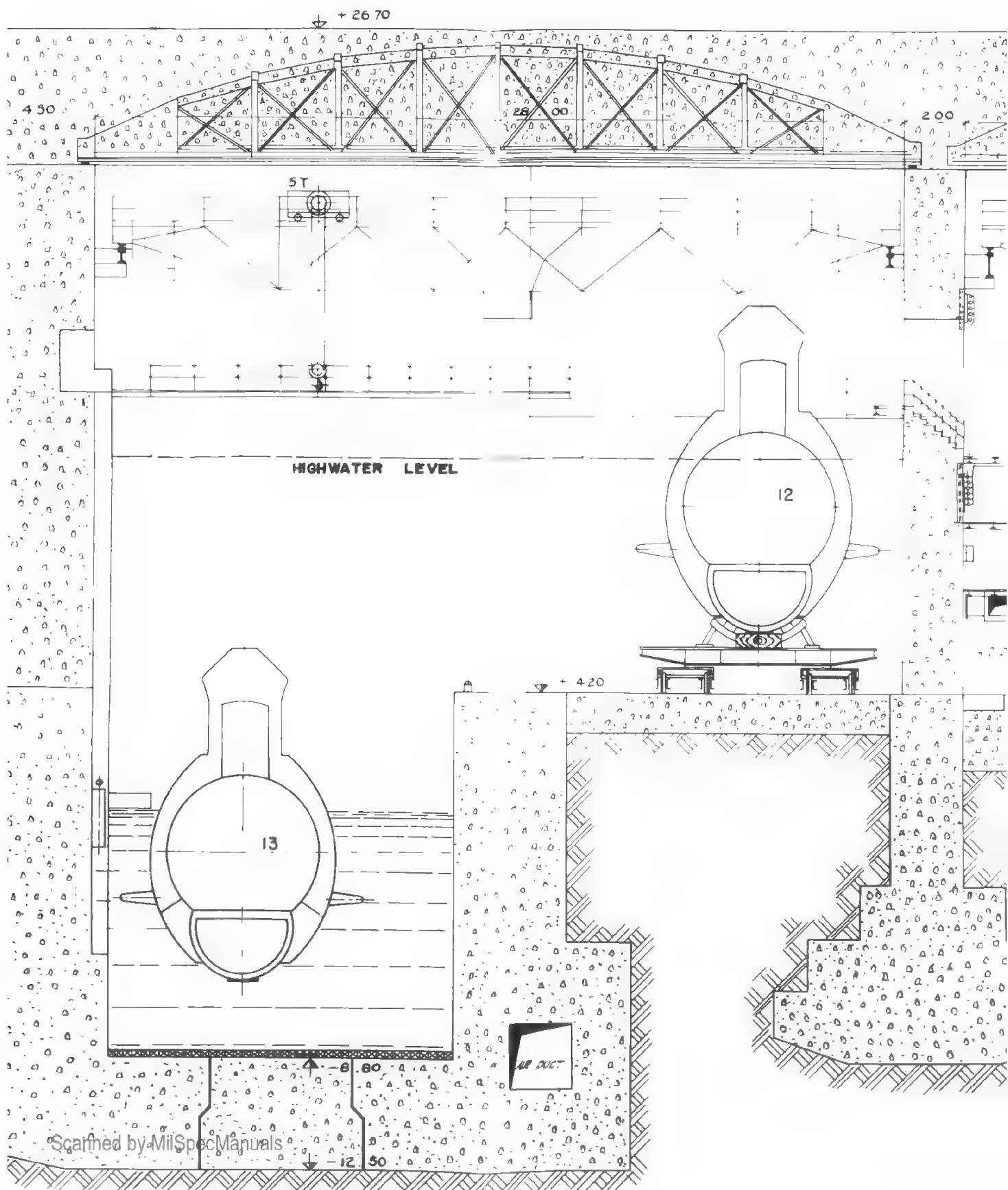
SCALE IN METERS

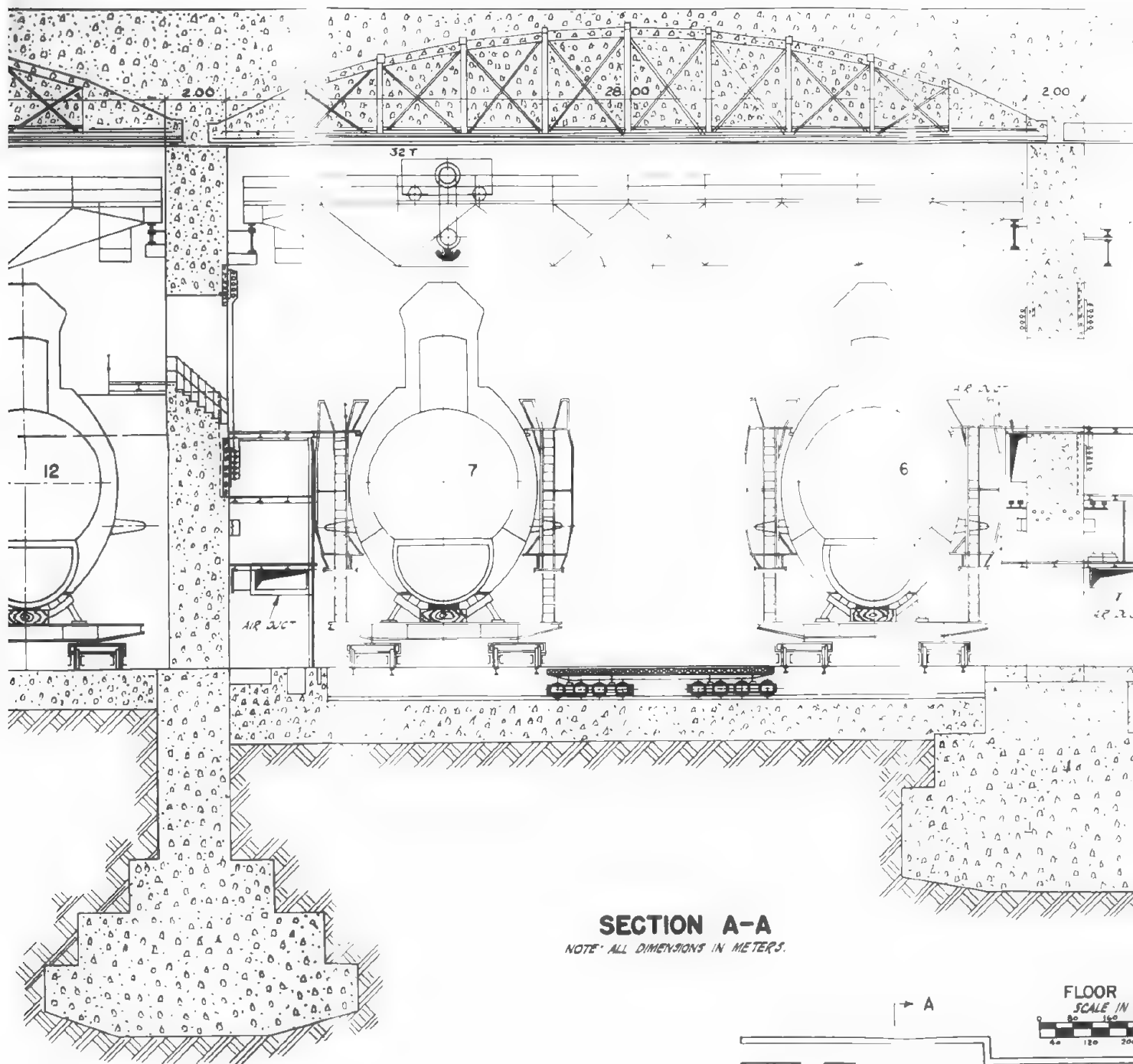


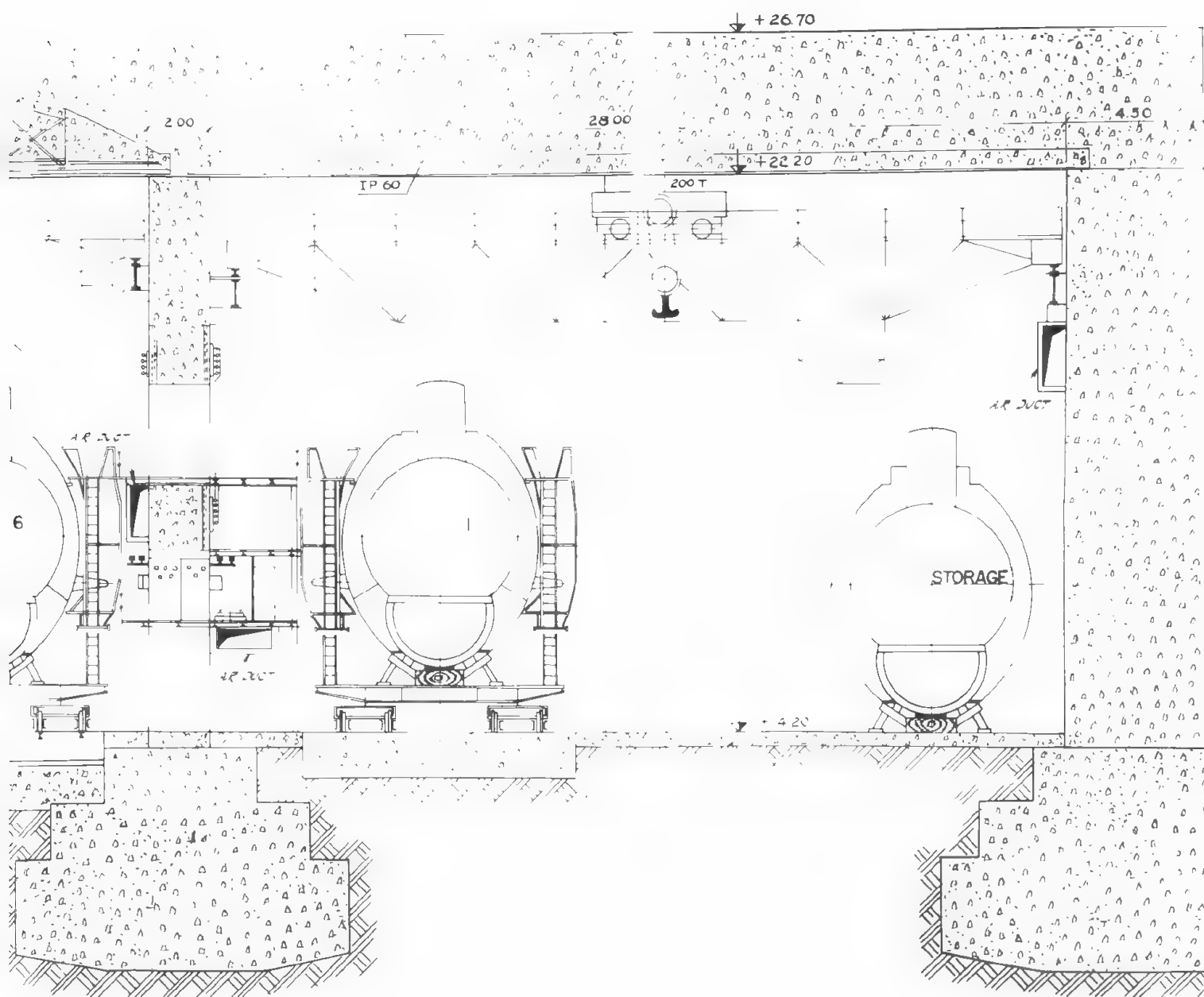
US STRATEGIC BOMBING SURVEY
LARGE SUBMARINE ASSEMBLY
WORKS
"VALENTIN"
EXHIBIT 8

TRANSVERSE SECTION

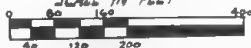


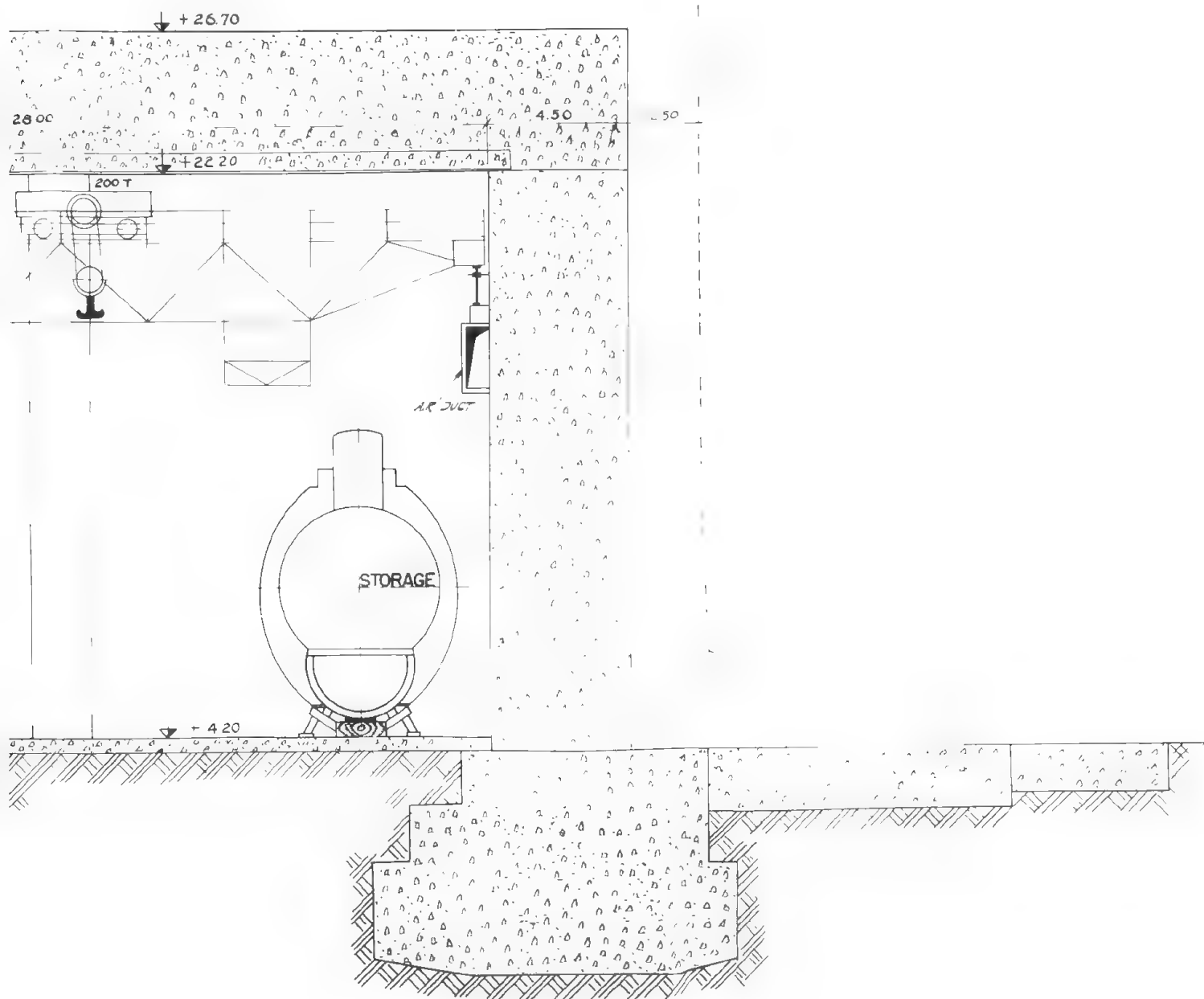






FLOOR PLAN
SCALE IN FEET





SCALE IN METERS



SCALE IN FEET



CROSS SECTION

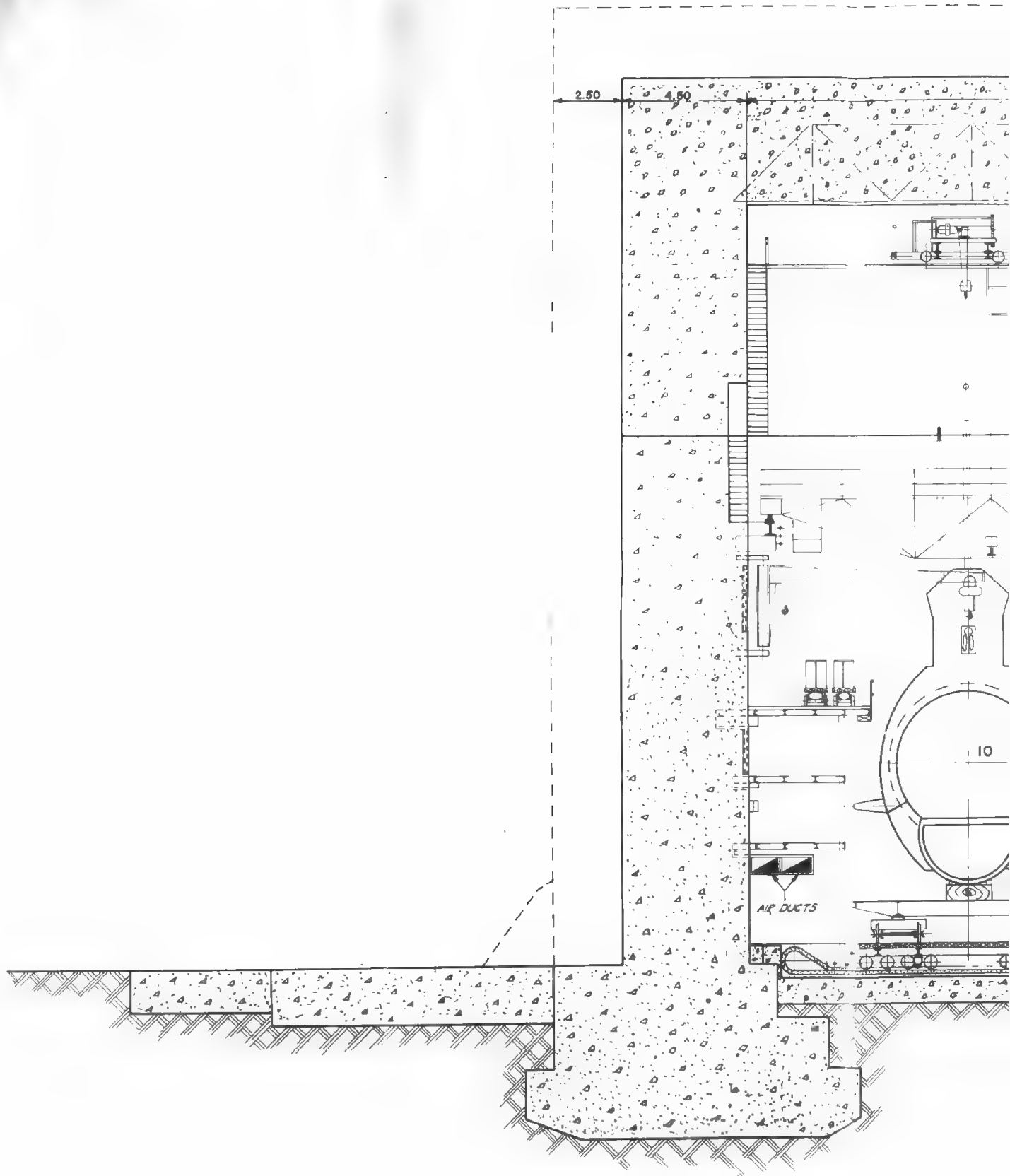
U.S. STRATEGIC BOMBING SURVEY

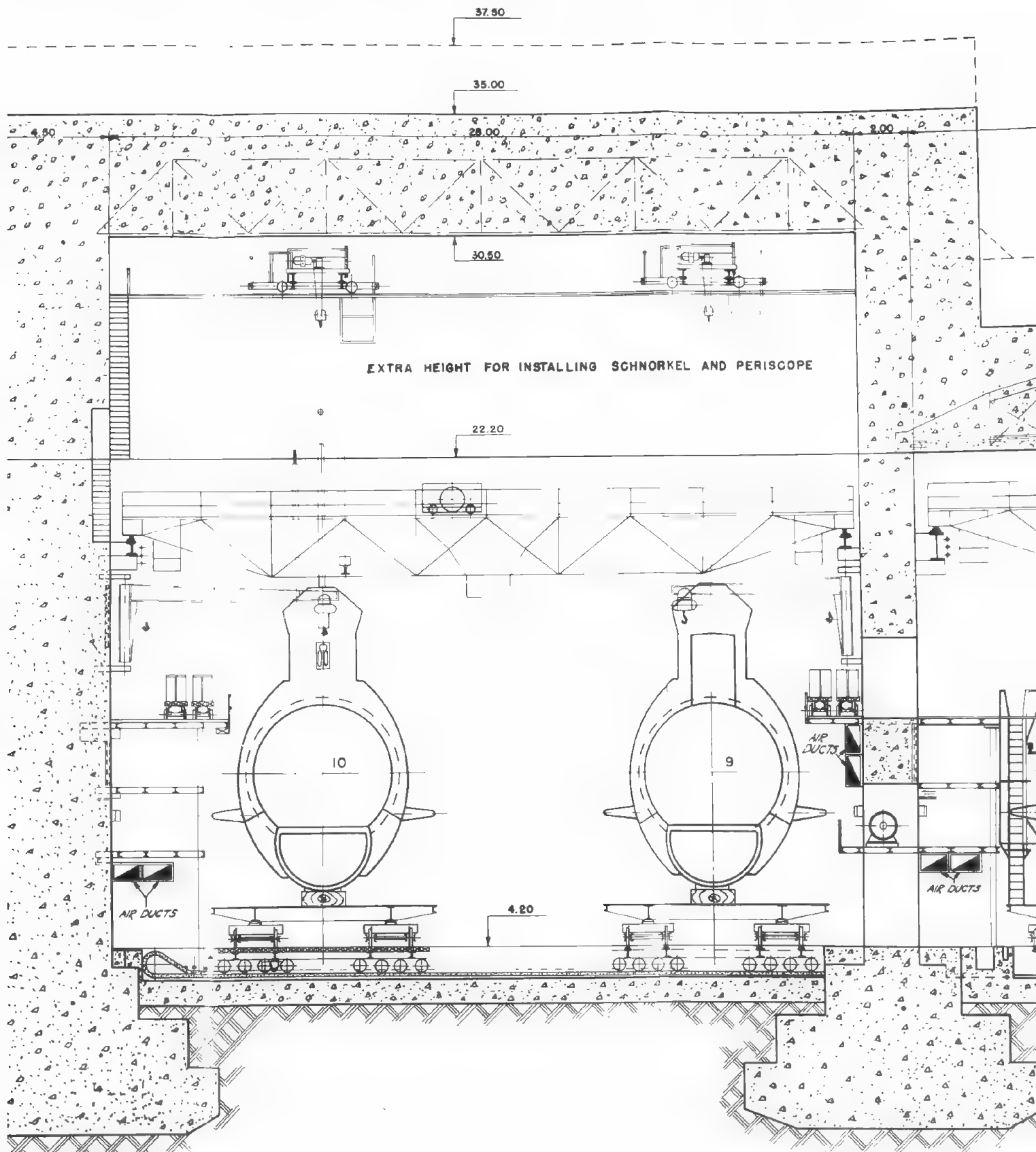
ARGE SUBMARINE

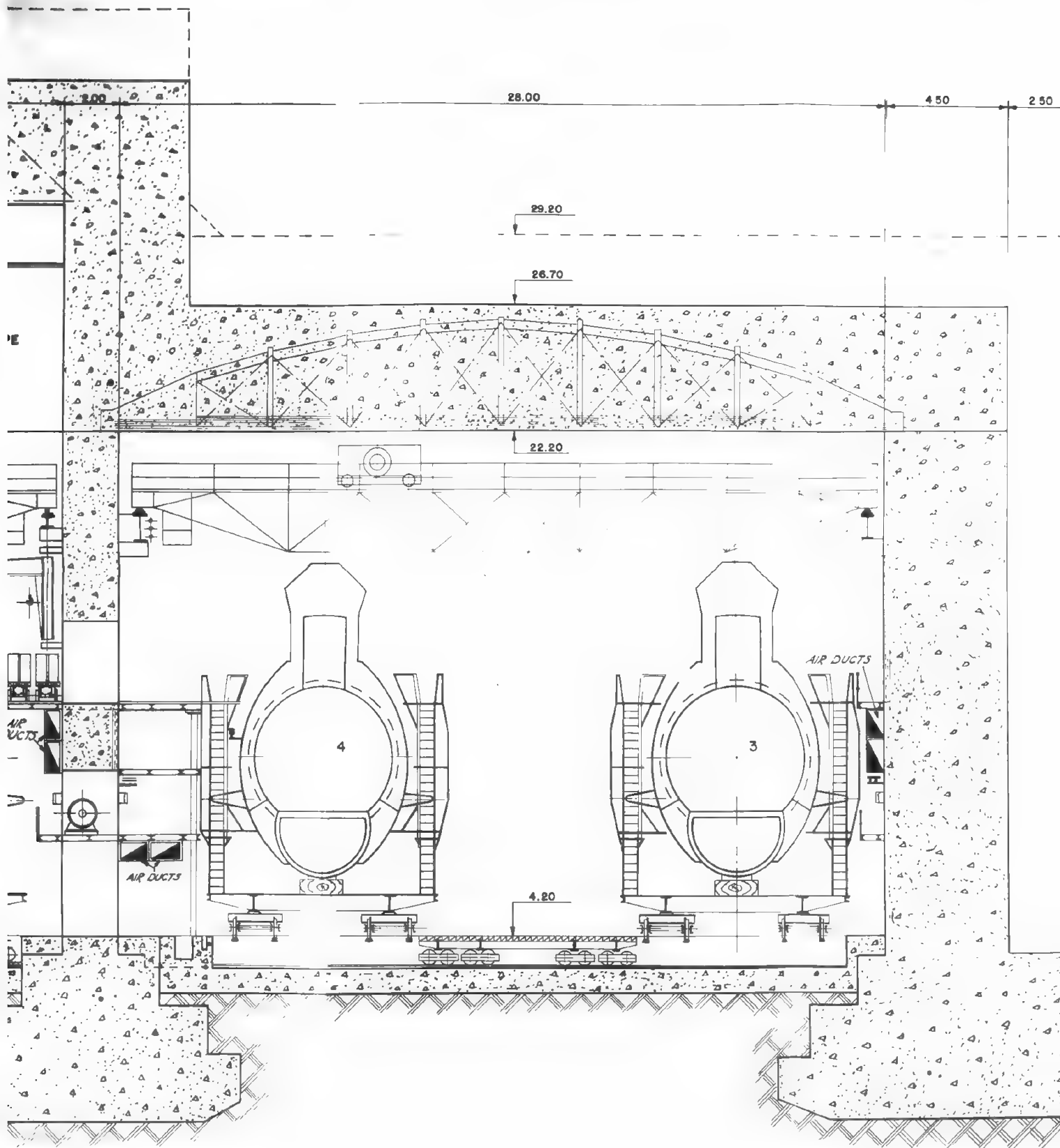
ASSEMBLY WORKS

"VALENTIN"

EXHIBIT C

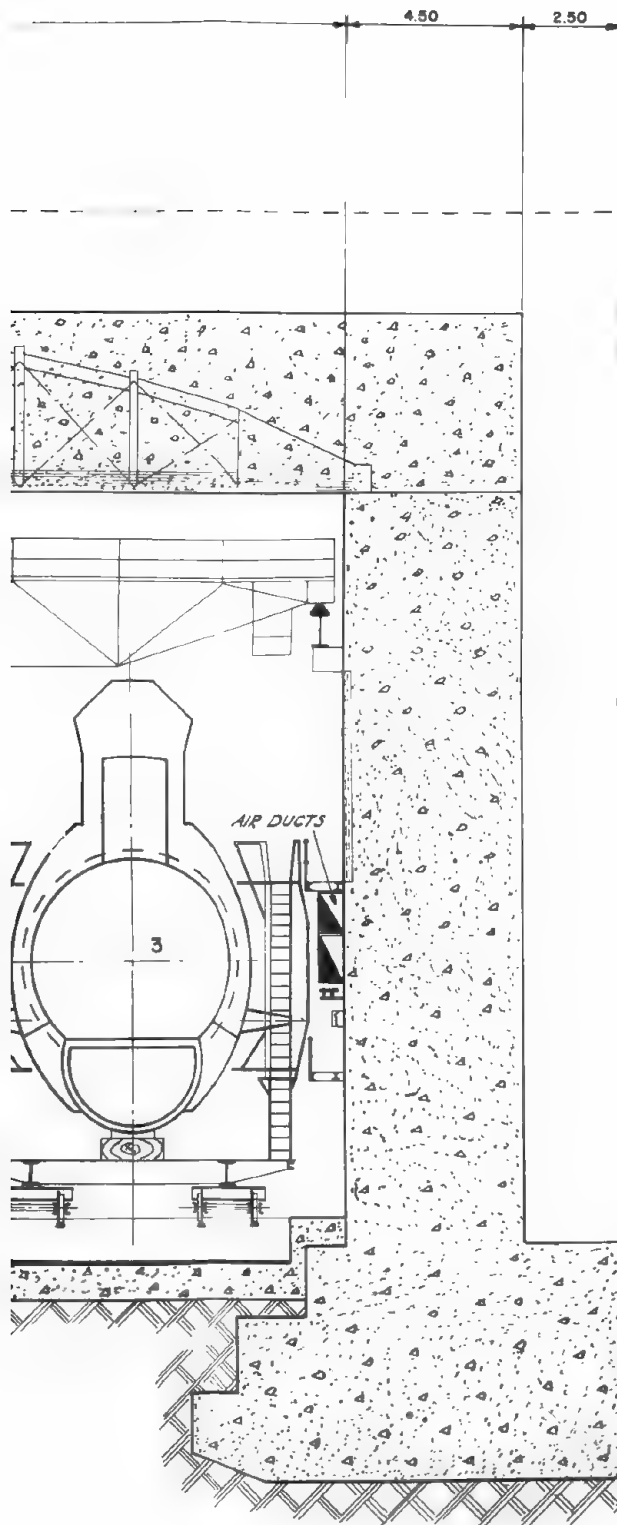
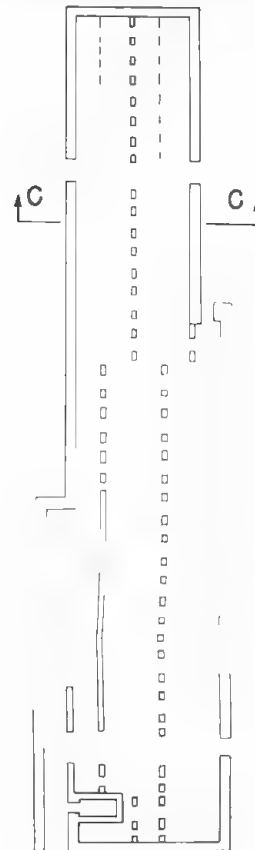






FLOOR PLAN

SCALE IN FEET



SCALE IN METERS



SCALE IN FEET



CROSS SECTION

U.S. STRATEGIC BOMBING SURVEY

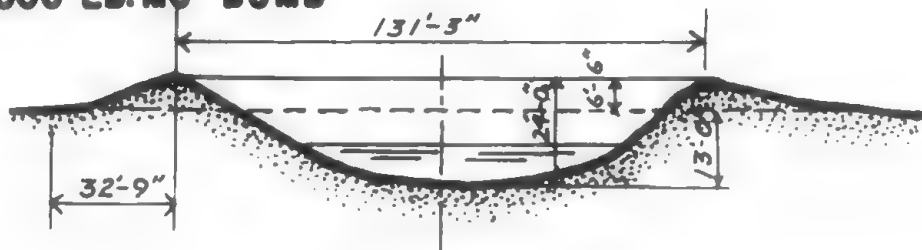
FARGE SUBMARINE
ASSEMBLY WORKS

"VALENTIN"

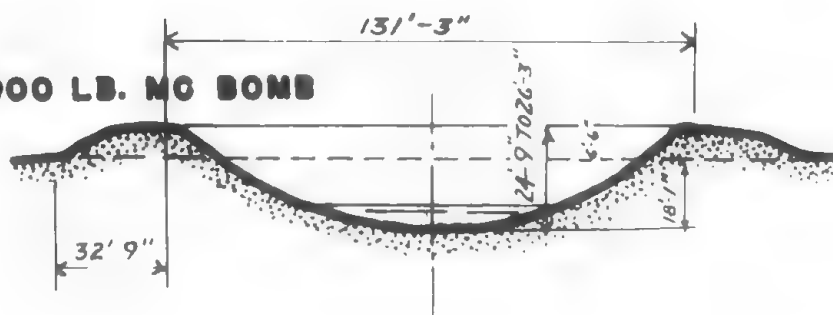
EXHIBIT D

BOMB CRATER PROFILES

① 22,000 LB. MO BOMB

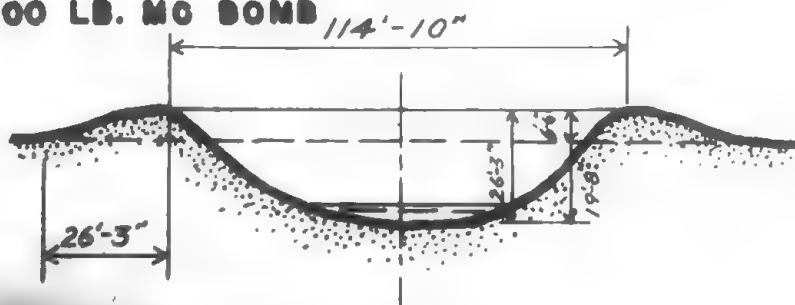


② 22,000 LB. MO BOMB



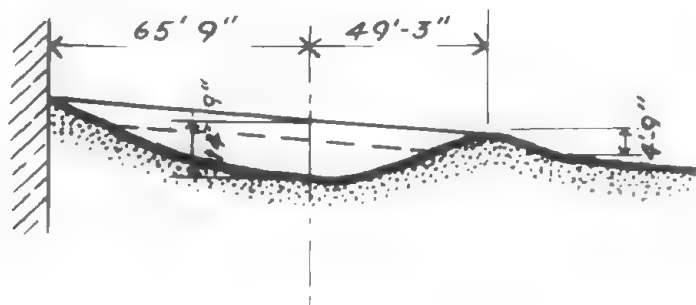
22,000 LB. MO BOMB

⑤



SCALE IN
0 10 20 30 40 50

⑦ 12,000 LB. MC BOMB

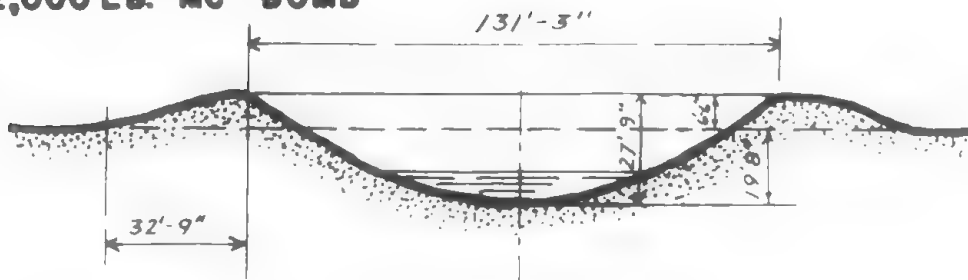


⑫



22,000 LB. MC BOMB

⑬



SCALE IN FEET

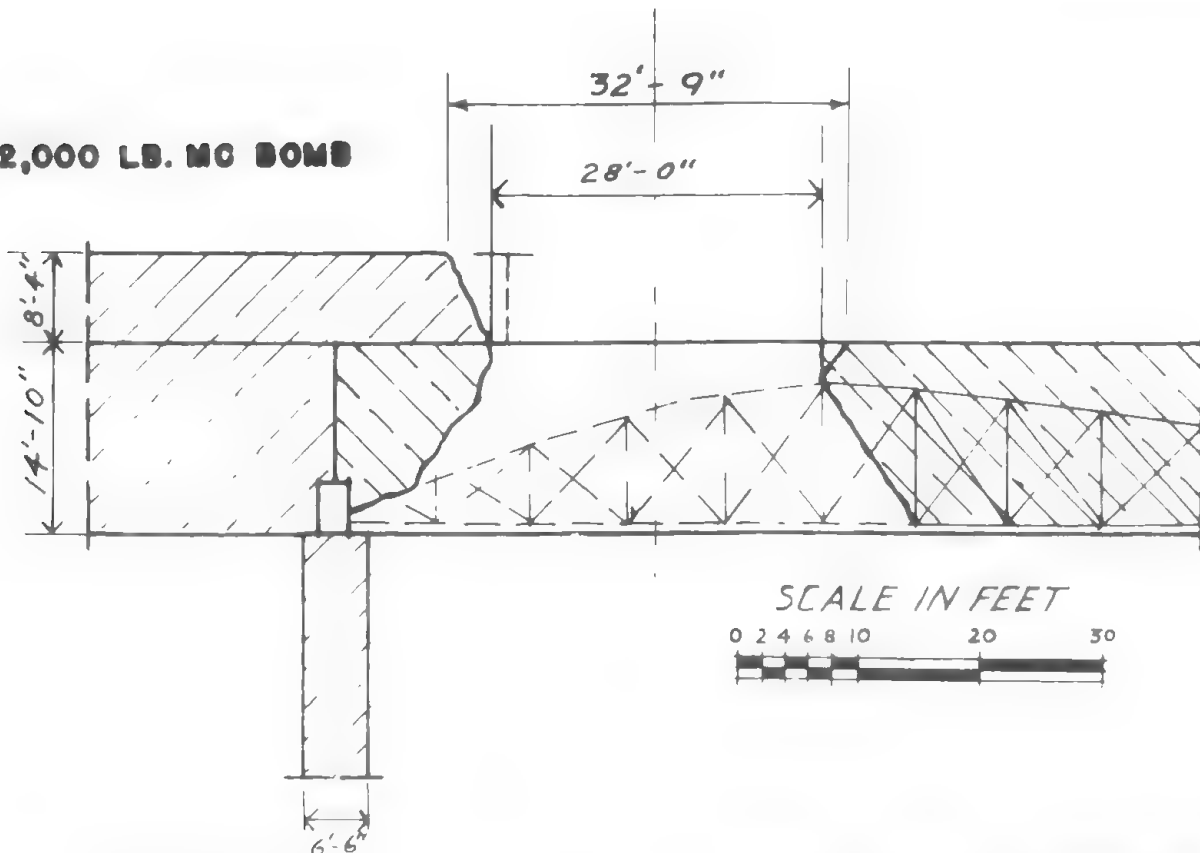


CROSS SECTIONS THRU CRATERS

RESTRICTED

22,000 LB. MC BOMB

①6



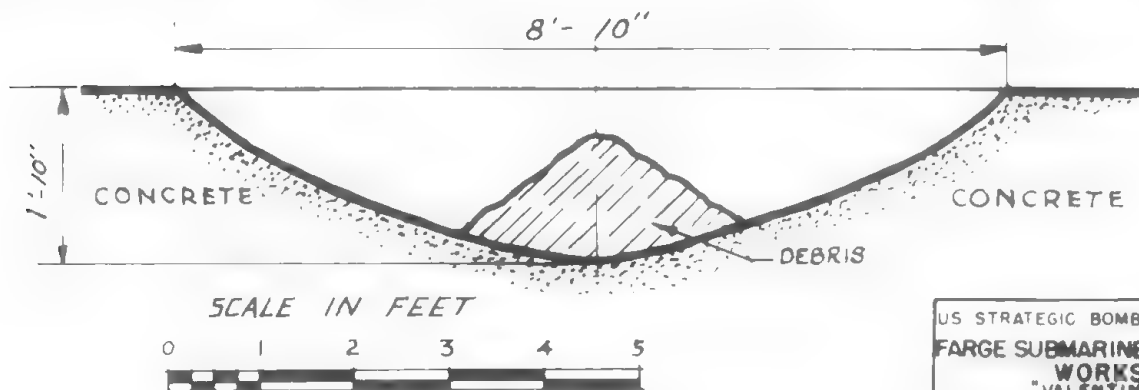
SCALE IN FEET



PROBABLE
4,000 LB RA/CP BOMB

①8

NOTE: SCALE DIFFERENT
FROM OTHERS



SCALE IN FEET



US STRATEGIC BOMBING SURVEY
FARGE SUBMARINE ASSEMBLY
WORKS
"VALENTINE"
EXHIBIT E

RESTRICTED

SUBMARINE SHELTER - VALENTIN

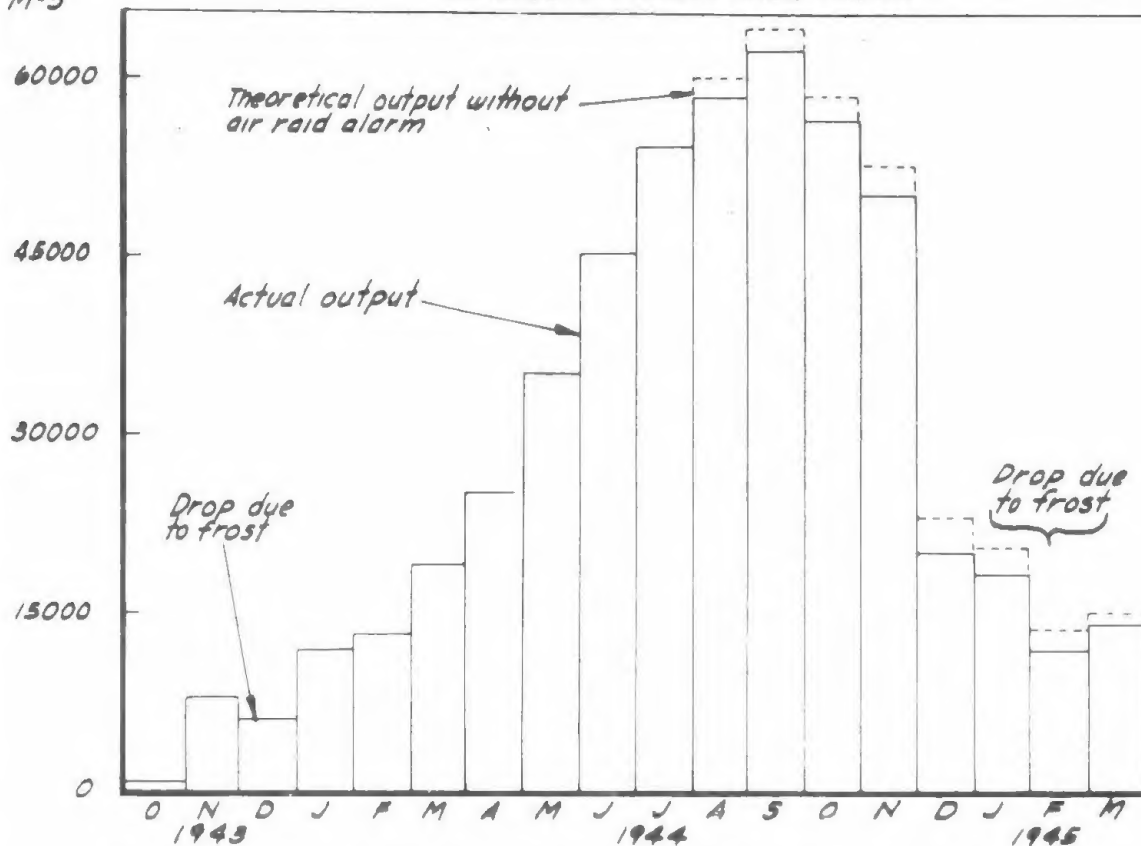
EXHIBIT F

MONTHLY CONSTRUCTION PROGRESS

CUMULATIVE CONSTRUCTION PROGRESS

CONSTRUCTION PROGRESS

FARGE SUBMARINE ASSEMBLY WORKS "VALENTINE"

EXHIBIT 'F'
M-3MONTHLY CONSTRUCTION PROGRESS
CONCRETE POURED EACH MONTHEXHIBIT 'G'
M-3CUMULATIVE CONSTRUCTION PROGRESS
TOTAL M3 OF CONCRETE POURED